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Hanford Site Groundwater Strategy

Protection, Monitoring, and Remediation

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Hanford Site Groundwater Strategy:

Protection, Monitoring, and Remediation

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1.0 Mission

The mission of the Hanford Groundwater Protection Program is to protect the Columbia River from contaminated groundwater resulting from past, present, and future operations at the Hanford Site and to protect and restore groundwater to its highest beneficial use. This mission is a key element of the overall Hanford cleanup efforts. This document provides a strategy to accomplish the mission through groundwater protection, monitoring, and remediation. This is a strategy document only - specific groundwater decisions will be made through the appropriate regulatory process. Additionally, this document identifies how the information related to this strategy and its implementation will be made available to interested parties.

2.0 Vision

The fundamental goal of the U.S. Department of Energy's (DOE's) Groundwater Protection Program is to protect human health and the environment from Hanford contamination and is a key piece of DOE's overall Hanford cleanup strategy. To accomplish this goal, groundwater protection, monitoring, and remediation activities at Hanford:

- Satisfy regulatory requirements.
- Integrate Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.
- Minimize duplication and reduce inconsistencies for monitoring and well drilling.
- Support vadose and groundwater cleanup decisions in a timely, effective, and efficient manner.

The groundwater strategy provides a consistent rationale to evaluate protection, monitoring, and remediation activities and identify gaps in groundwater and vadose remedial actions. The strategy guides field activities conducted on the Hanford Site and facilitates annual negotiations between the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology) and DOE (Tri-Parties) and the related work planning. The Tri-Parties' goal is to implement a strategy that minimizes adverse effects to groundwater during site operations and cleanup.

3.0 Goals and Objectives

The goals and objectives of this groundwater strategy are to:

- Provide a clear mechanism to achieve the mission of the Hanford Groundwater Program through minimizing overlapping programmatic/regulatory requirements of RCRA, CERCLA, AEA, and the Model Toxics Control Act (WAC 173-340).
- Identify regulatory requirements and environmental objectives to protect, monitor, and remediate groundwater.
- Provide a framework that relates data needs to the decision making needed for remedial activities and monitoring.
- Develop a strategy that can be adapted as new information emerges.

- Identify and integrate policy issues that affect the Tri-Parties.
- Focus action on the reduction of risk; characterization, monitoring, and other activities should be done to support that end.
- Protect and remediate groundwater considering the cumulative impact of waste remaining at Hanford, regulatory requirements, and stakeholder values.
- Meet risk-based cleanup objectives through an appropriate combination of reduction of contaminant mass and containment of plumes to minimize the spread of contamination.
- Minimize further degradation of groundwater during remedial and closure activities (e.g., tank waste retrieval), including the reduction of preferential pathways (such as abandoned wells).

4.0 Regulatory Integration

Hanford groundwater protection, monitoring, and remediation actions are guided by both federal and Washington State regulations. The primary relevant acts are RCRA, CERCLA, and AEA.

4.1 RCRA Groundwater Activities

Groundwater monitoring at Hanford under RCRA requirements and the implementing regulations of the Washington Administrative Code (WAC) 173-303 focuses on several key areas:

- Verification of safe operation and management of currently active land-based waste management units (i.e., landfills and surface impoundments) that will protect groundwater.
- Verification of closure performance standards for clean up of groundwater and monitoring of groundwater for closed/closing land-based regulated units.
- Corrective action for solid waste management units (RCRA past-practice units identified in the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, Ecology et al. 1998) Appendix C nomenclature.

In accordance with Tri-Party Agreement milestone M-20, all groundwater monitoring requirements will be included in the Hanford sitewide permit under authority of WAC 173-303-645 and WAC 173-303-646. Although not all RCRA units enumerated in Appendices B and C of the Tri-Party Agreement have been incorporated into the sitewide permit, this strategy is based on the long-term goal of basing groundwater monitoring requirements on the final status and corrective action requirements cited in these WAC requirements.

Groundwater monitoring for active land-based units (i.e., landfills and surface impoundments) is conducted on a unit-specific basis to document that current waste management activities do not adversely affect groundwater. Groundwater monitoring for closed/closing land-based units may either be on a unit-specific basis or as part of a broader groundwater operable unit monitoring system. The monitoring approach selected for a particular waste management unit depends on a number of factors that include the source inventory of the waste management unit, the mobility and toxicity of waste or constituents in the waste management unit, similarity of contamination in the waste management unit and the associated groundwater operable unit, and the relative contribution of contamination from the waste management unit compared to the associated groundwater operable unit.

Groundwater monitoring for single-shell tanks is a complex, special case that is dealt with separately under Tri-Party Agreement milestones M-24 and M-45. Single-shell tanks are considered non-compliant tank systems with documented releases to the environment, but which must continue to be used to manage waste for an extended period of time pending retrieval and closure. Groundwater monitoring at the single-shell tanks supports numerous environmental and regulatory data needs, including evaluating the sources of groundwater and vadose contamination, the fate and transport of existing and potential future releases, the aquifer characteristics for purposes of evaluating retrieval technologies, and the long-term risk for purposes of developing closure performance standards and post-closure care requirements.

4.2 CERCLA Groundwater Activities

The Hanford Site has been divided into 56 operable units, or groupings of similar waste units within a geographic area, so that the CERCLA process established in the National Oil and Hazardous Substances Contingency Plan (40 CFR 300) can be efficiently implemented. Forty-six are source operable units and 10 are ground water operable units. Groundwater monitoring and related site characterization for operable units are treated separately to allow for differences between the more localized contaminants in the soil column at the sources and the more widespread distribution of groundwater contaminant plumes that have resulted from one or more individual sources. The concept of the groundwater operable unit was adopted to allow separate characterization of the source operable units and the groundwater. There are 10 groundwater operable units at the Hanford Site. Monitoring wells are located and sampled in accordance with Remedial Investigation/Feasibility Study (RI/FS) work plans to define the nature and extent of the contaminant plume(s).

In developing a sitewide groundwater monitoring strategy, the Tri-Parties recognize the distinction between groundwater remediation and source remediation. Characterization and monitoring are essential elements of both. Also, the Tri-Parties recognize the distinction between active waste management units and waste sites undergoing cleanup.

EPA, DOE, and Ecology affirm Section 5.5 of the Tri-Party Agreement (Ecology et al. 1998), which recognizes the need to coordinate the application of regulatory requirements, and recognize that past-practice authority may provide the most efficient means to address groundwater plumes of mixed waste originating from a combination of past-practice treatment, storage, and disposal units. Groundwater response actions for which EPA is the lead regulatory agency shall ensure compliance with the technical requirements of RCW 70.105 and implementing regulations. Notwithstanding this operating assumption, Ecology reserves the right to exercise its authority under RCW 70.105 to require response actions specific to the treatment, storage, and disposal facilities.

4.3 Atomic Energy Act Groundwater Activities

Under the authority of AEA, DOE is required to implement a groundwater program at Hanford. Groundwater that is or could be affected by DOE activities shall be monitored to determine and document the effects of operations on groundwater quality and quantity and to demonstrate compliance with DOE requirements and applicable federal, state, and local laws and regulations. The plan shall identify all DOE requirements and regulations applicable to groundwater protection and include an appropriate monitoring strategy. The elements of the groundwater monitoring program shall be specified (sampling plan, sampling, analysis, and data management), as shall the rationale or purpose for selecting these elements. Groundwater monitoring programs shall be conducted on-site and in the vicinity of DOE facilities to:

(1) Obtain data for the purpose of determining baseline conditions of groundwater quality and quantity.

(2) Demonstrate compliance with and implementation of all applicable regulations and DOE Orders.

(3) Provide data to permit the early detection of groundwater pollution or contamination.

(4) Provide a reporting mechanism for detected groundwater pollution or contamination.

(5) Identify existing and potential groundwater contamination sources and to maintain surveillance of these sources.

(6) Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

Site-specific characteristics shall determine monitoring needs. Where appropriate, groundwater monitoring programs shall be designed and implemented in accordance with 40 CFR 264, Subpart F, or 40 CFR 265, Subpart F. For sites with multiple sources of groundwater pollutants, extensive groundwater pollution, or other unique site problems, groundwater monitoring programs could require more extensive information than those specified in 40 CFR 264 and 265. Monitoring for radionuclides shall be in accordance with DOE Orders in the 5400 series dealing with radiation protection of the public and the environment.

Additional regulatory analysis is provided in Appendix C of this document.

5.0 Strategies

This groundwater strategy focuses on three key areas:

- Groundwater protection.
- Groundwater monitoring.
- Remediation of contaminated groundwater.

Strategy elements for each of these areas are presented in the following sections. Each section also identifies areas for technology improvements and the role of groundwater modeling. Actions to be taken to communicate groundwater plans and the results of actions taken are discussed in Section 6.

5.1 Groundwater Protection

Once deep vadose zone and/or groundwater becomes contaminated it is difficult and costly to remediate. Therefore, prevention of future groundwater contamination and containment of existing near-surface contamination are the primary ways to protect groundwater. Key activities in preventing future groundwater contamination include operating and managing properly the existing and new land-based waste storage and disposal facilities, removing or immobilizing contaminant sources before contamination can reach groundwater, reducing natural and artificial recharge in contaminated areas, and eliminating the opportunity for contaminants to move rapidly to groundwater along unsealed well casings and through deteriorating wells that are no longer needed or used.

5.1.1 Groundwater Protection Framework

Operation of Waste Storage and Disposal Facilities. Permanent onsite disposal of waste is an integral component of the overall Hanford cleanup mission, including clean up and protection of groundwater. Consistent with the “cradle-to-grave” waste management model of RCRA and RCW 70.105, all aspects of managing this waste must be based on the principle of preventing human health or environmental harm through proper waste management practices. Proper operation of active waste storage and disposal facilities is a key element to assure continued protection of groundwater. Avoiding new and/or preventing additional contamination from entering the groundwater from both new and existing operations must become a primary objective in facility management. Design and operation of waste management units currently accepting RCRA regulated waste (including new or expanded units) must reflect the basic minimum technology (double liner, leak detection, etc.) and groundwater monitoring requirements of RCRA. More specifically, waste disposal units are fully subject to the traditional groundwater detection monitoring, compliance monitoring, and corrective action requirements of WAC 173-303-645.

Removal or Immobilization of Contaminant Sources. Removal of contaminant sources, immobilization of the waste, remediation of waste releases at the sources, and/or minimization of contaminant transport at the sources helps protect groundwater by controlling the source of the contaminants. Considerable progress has been made in the Columbia River corridor in this respect. Plans are being developed to accelerate the cleanup of the remaining sites in the river corridor, and accelerate cleanup of the core zone (Figure 1) including treating tank waste, remediating waste sites, and decommissioning excess facilities (DOE/RL 2002). Each of the actions taken in these areas will reduce the potential for degradation of groundwater quality.

Reducing Natural and Artificial Recharge in Contaminated Areas. Reducing natural and artificial recharge in contaminated areas protects groundwater by reducing the transport of contaminants through the vadose zone into the unconfined aquifer. Much has been done at the site to eliminate discharge of cooling and process water to ground. Work has begun to provide run-on/runoff control measures in and around tank farms, remove unnecessary water lines, and test necessary water lines to reduce recharge from precipitation and water line leaks.

Decommissioning Unnecessary Wells. There are many wells and borings that no longer serve a useful purpose on the Hanford Site. These wells and borings can provide an avenue to speed contamination through the vadose zone to the unconfined aquifer and possibly deeper. These wells and borings fall into three broad categories:

- Wells that have gone dry due to the decline of the top of the unconfined aquifer.
- Older wells that are noncompliant.
- Wells that no longer serve an exploration, assessment, or regulatory purpose.

To aid in protecting the aquifer from mobile contamination, it is imperative that these wells and borings be removed. When it is determined that they are not necessary and/or will not or cannot be used, then they should be properly decommissioned. As part of the groundwater protection strategy, a priority ranking system will be developed to determine which wells pose the highest environmental risk and, therefore, should be decommissioned first.

Science and Technology. There is a long-term need for science and technology to support groundwater protection on the Hanford Site. Cost reduction and improved effectiveness of protection actions can be realized through continuing investments in these areas.

Modeling and Assessment to Support Groundwater Protection. As alternate disposal and remedial actions are considered, computer models are used to assess the cumulative risk and impact of materials left at the Hanford Site. For groundwater protection, models can be used to:

- Identify and rank sites according to those that pose a future threat to groundwater quality, (e.g., magnitude of flux of contaminant through the water table).
- Assist in the prioritization of waste sites for accelerated action (e.g., contribute the risk to public information to profiles of cost, schedule, worker risk and, therefore, develop comparisons of alternate actions).

The assessments performed with the help of models will complement the data collected on the performance of implemented disposal and remedial actions (e.g., from the 5-year reviews), and provide the final cumulative assessment of long-term risk and impact prior to Hanford Site closure.

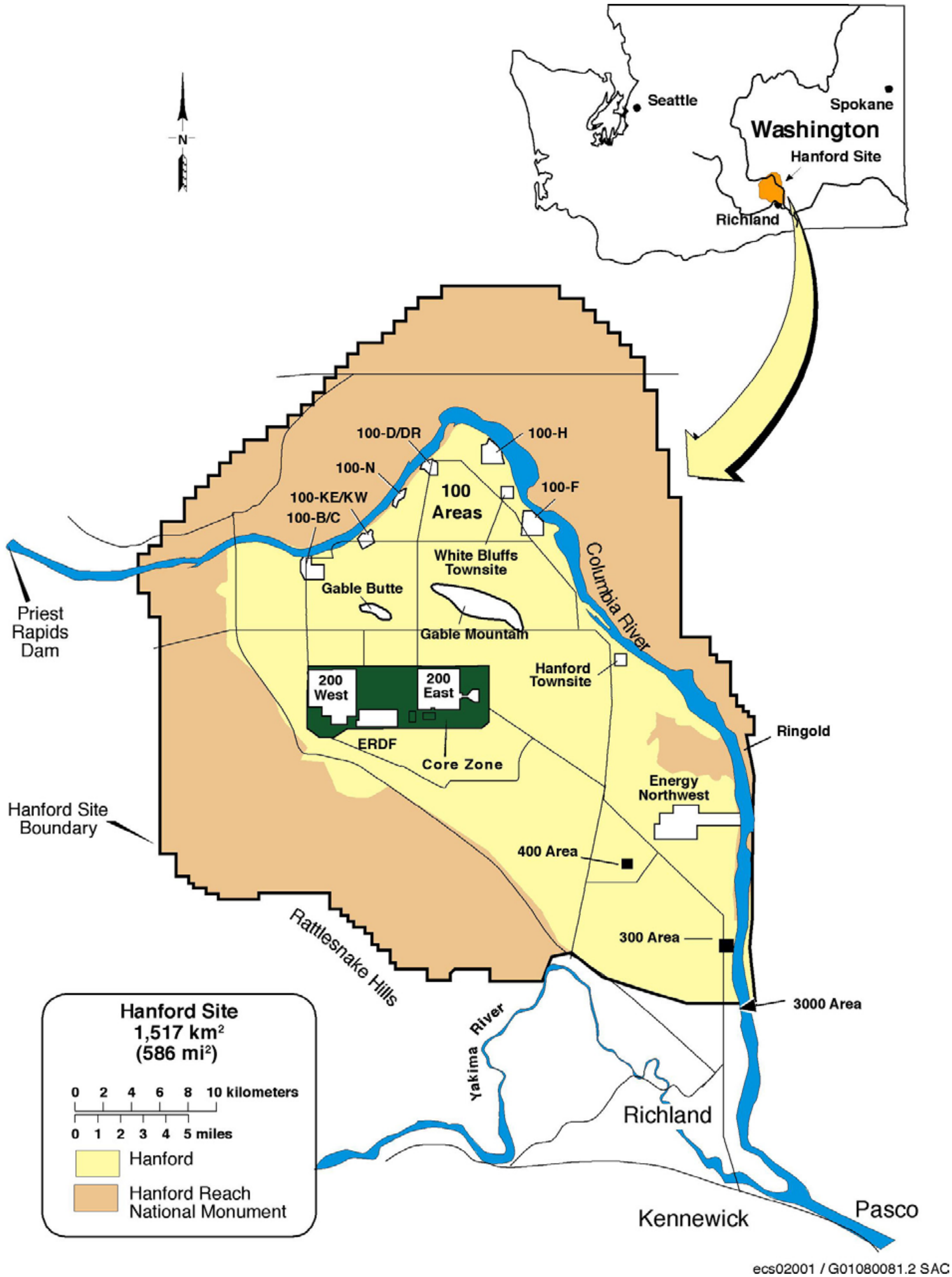

Figure 1. Location of key features on the Hanford Site

5.1.2 Considerations for Near-Term Action

DOE will continue to operate Hanford waste treatment, storage and disposal facilities in accordance with permits and applicable regulations. Waste sites will be reviewed to identify sites that warrant accelerated removal of the source. Sites also will be reviewed to identify opportunities to reduce recharge and transport of contaminants into groundwater through placement of interim covers and run-on/runoff control measures. This effort will focus on sites with significant inventory of long-lived, mobile radionuclides and chemicals where there is an opportunity to slow or delay the release of this material to the groundwater.

The water supply and disposal infrastructure in the core zone (see Figure 1) also will be examined to identify actions that can be taken to reduce influx of water near waste sites. This may include the cutting and capping of water lines and reduction of sanitary sewer disposal in the vicinity of waste sites. In addition, unused wells in areas where they continue to offer a potential pathway for contaminants to reach groundwater will be given a high priority for decommissioning.

Technology development will continue to help characterize where contaminants are and how they are moving as well as identify improved methods for remediation. Improved characterization of carbon tetrachloride distribution and movement in the vadose zone is needed in the near term to prepare for making remediation decisions. Improved technologies for removing or immobilizing waste in the vadose zone and preventing its entry into the groundwater and the Columbia River will continue to be important. The Science and Technology Roadmap (DOE/RL 2000) will continue to be used to link the needs of cleanup projects to science and technology investigations.

5.1.3 Considerations for Final Protection Efforts

The character of waste in tanks at Hanford remains key to protecting groundwater beneath the site. An important component of this groundwater strategy is the development of tank retrieval technologies that will limit the loss of tank waste during retrieval operations.

For many past-practice waste sites in the Central Plateau that have long-lived contaminants that are already deep in the vadose zone, the placement of covers or barriers over the site may be the only practicable action to reduce the movement of contaminants and delay their entry into groundwater. Continued research into effective methods to immobilize or remove these contaminants should be pursued. Examples of improved technology identified in the Science and Technology Roadmap (DOE/RL 2000) are six-phase heating to remediate carbon tetrachloride in the vadose zone and work to improve the performance of waste site covers.

5.2 Groundwater Monitoring

Groundwater monitoring is conducted to:

- Detect effects to groundwater from operating and past practice waste sites.
- Determine the nature and extent of groundwater contamination so that appropriate action can be taken.
- Assess the effectiveness of groundwater remediation activities.
- Verify that Hanford Site contaminants are not present in offsite groundwater.
- Determine hydraulic head to determine groundwater flow rate and direction.

5.2.1 Groundwater Monitoring Framework

Groundwater monitoring will be performed to support cleanup decisions and to verify that land-based disposal units are properly designed and operated to prevent impact to groundwater. Groundwater monitoring needs are defined principally by regulatory requirements of RCRA (including the technical requirements pertinent to Model Toxics Control Act (WAC 173-340) standards), CERCLA and AEA and directly support agreed-upon cleanup goals. Once these monitoring needs are defined, an enforceable regulatory pathway and/or decision document under RCRA or CERCLA can be developed. Where cleanup-driven requirements do not naturally match regulatory requirements, there should be a bias toward interpretation and application of regulations that best support cleanup goals. Ultimately, of course, monitoring requirements must demonstrate compliance with applicable rules, regulations, and the Tri-Party Agreement (Ecology et al. 1998). Once developed, requirements must be reflected in enforceable decision documents.

The EPA's data quality objectives (DQO) process was successfully used to integrate the RCRA, CERCLA, and AEA groundwater monitoring requirements in the 200 West Area, and will be used as a model for the remaining groundwater regions. The DQO process is a seven-step decision making process that requires the user to clearly:

- Define the problem needing to be resolved
- Identify the decisions that need to be made
- Identify the inputs needed to resolve the decisions
- Define the boundaries of the study area
- Identify decision rules
- Define tolerable limits on decision error
- Identify the optimum sampling design

The success of the DQO process for 200 West Area had much to do with DOE, EPA, and Ecology being encouraged to provide input prior to beginning the DQO process, as well as throughout the process. For example, DOE, EPA, and Ecology were interviewed separately prior to beginning the DQO process to identify specific issues and concerns that they wanted taken into consideration in the final sampling design. This input was used to develop a pre-draft "strawman" DQO Summary Report. A separate meeting was held with DOE, EPA, and Ecology to introduce them to the "strawman" DQO Summary Report, and to get their preliminary feedback. This feedback was integrated into the document to develop the Draft DQO Summary Report, which was issued for comprehensive review.

Once contamination is detected, monitoring and related activities are undertaken to assess the nature and extent of groundwater contamination so that appropriate action can be taken. Appropriate action may vary depending on the risk associated with the contamination as indicated by the mass of contaminant involved, its mobility and persistence in the environment, and its toxicity.

The following strategy provides a common, sitewide perspective to guide the development of assessment activities for individual groundwater operable units and, when appropriate, groups of waste sites. Guiding principles are developed within the context of existing groundwater conditions, the regulatory framework for remediation, and stakeholder values. These principles for a comprehensive groundwater assessment approach are summarized below:

- When a new plume/contamination is discovered within an existing plume, assessment of the new plume/contamination should be incorporated into the ongoing assessment of the existing plume as long as the cleanup goals/objectives of both are the same. For other plumes, assessment actions will be undertaken once contaminant concentrations are detected in groundwater above an agreed to threshold. Whenever possible, predictions of future conditions with reliable estimates or known inventory information will be used as a tool to locate future monitoring wells and determine future monitoring requirements.

- Monitoring and characterization of waste sites will use a graded approach, focusing resources on sites that have a large inventory of long-lived and mobile contaminants. Groundwater monitoring and characterization of contaminant plumes also will use a graded approach, focusing resources on plumes that may pose a threat to the Columbia River or groundwater. The vast majority of such contamination occurs in the 200 Areas. First priority will be given to waste sites and groundwater contaminant plumes (e.g., carbon tetrachloride, single-shell tanks, specific retention trenches and cribs that received tank waste) that have a known or suspected inventory of long-lived and mobile contaminants sufficient to pose a threat to the Columbia River or to affect groundwater resources outside of the 200 Areas core zone. The three groundwater plumes associated with the PUREX Plant operations (tritium, nitrate, and iodine-129) are expected to attenuate through natural processes. These plumes do not currently pose a risk to human health or the environment and risk from these plumes is not expected to increase in the future. It is the goal of this strategy to prevent 200 Area contaminants from recontaminating the aquifer outside of the 200 Area core zone. Attainment of this goal also will assure protection of the Columbia River and its users.
- For monitoring needs of single-shell tank waste management areas refer to Appendix C of this document.
- When practicable vadose zone monitoring will be considered to allow the early detection of contamination before it reaches groundwater.
- If contamination from a facility is detected, an evaluation will be performed to identify what needs to be done to correct the problem.
- Predictions of future conditions will be used to establish the thresholds for triggering assessments and identify the mass of contaminant that constitutes a threat to groundwater degradation.

Waste sites contributing to groundwater contamination in the core zone are likely to impact existing, partially or well-defined plumes. Assessment of existing and new sources should be undertaken in a phased manner. The first screening phase should evaluate whether the source area is likely to significantly impact the underlying plume, or whether the new source contribution is within the capability of any remediation system in place. Criteria might include:

- Mass flux from source areas compared to the mass and distribution of contaminants in the underlying plume.
- Contaminants in the source area compared to the underlying plume (chemical nature, mobility).
- Capability of any containment/remediation system to accommodate releases from the source area.

If results of the first phase of investigation indicate that (1) the source area is not a significant contributor to the underlying plume or (2) any releases from the source area can be effectively addressed by existing remediation systems, then further assessment/characterization is not warranted at that site.

If results of the first phase of investigation indicate that (1) the source area is a potentially significant contributor to contamination or (2) modifications to the remediation system at the source area might be needed, then additional characterization is warranted to determine what additional remediation might be necessary. A generalized decision logic for this process is provided in Figure 2.

Land-based RCRA-regulated units that currently accept or actively manage waste are a special case. For these units, the principal monitoring goal is to demonstrate that the engineered unit is performing satisfactorily and providing releases to the environment, rather than provide information to be used in the cleanup of past releases or existing plumes. Further, there is less flexibility in implementing

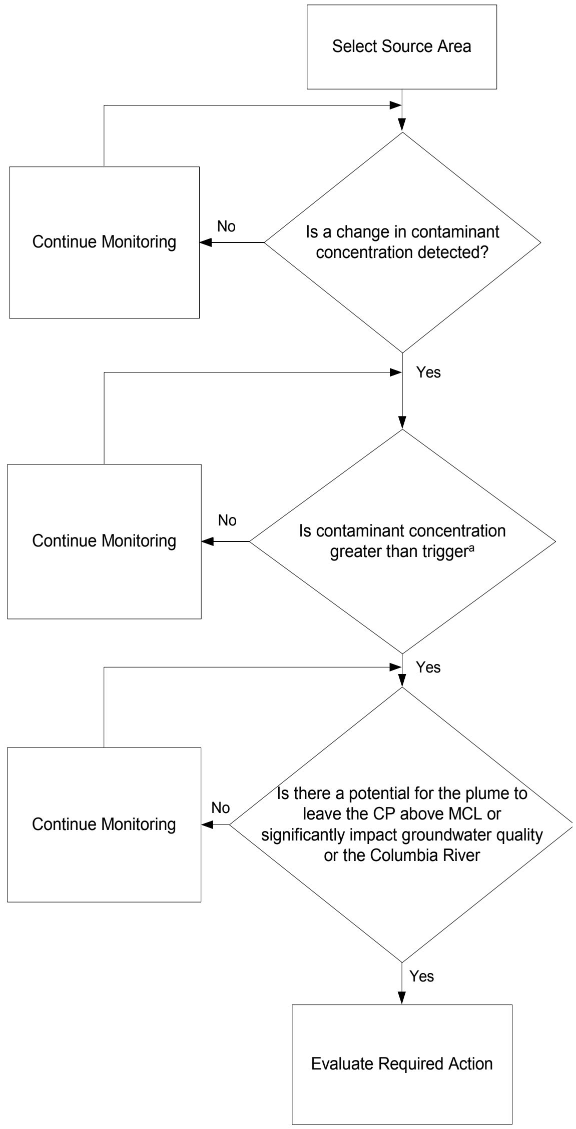

Figure 2. Generalized decision logic for assessment and remediation of groundwater

Subpart F WAC 173-303-645 proscriptive groundwater monitoring requirements compared to monitoring associated with cleanup. Even within this context, the groundwater monitoring points should be evaluated to best serve the requirements of disposal unit monitoring and groundwater plume cleanup. This includes monitoring points near potential leaks from tanks undergoing waste retrieval.

Groundwater monitoring is described in more detail in the environmental monitoring plan developed for Hanford (DOE/RL 1997).

Science and Technology. There is a need for continued technology development to support groundwater monitoring. Technologies that will provide improved information at lower cost can be used during the active cleanup phase and could greatly reduce the cost of long-term stewardship. Advances will not be possible without continuing investments in science and technology.

Modeling and Assessment to Support Groundwater Monitoring. Computer modeling has long been used to assist in designing networks of groundwater monitoring wells. Models used have included complex, sitewide groundwater models to help identify where and when contaminants might reach the point of compliance or point of concern so that monitoring wells can be located with the best chance of detecting the first arrival of contamination and of monitoring the movement of any plumes. Computer models also have included the aquifer hydraulic model, (i.e., providing predictions of water-table elevation), that is used to identify wells that require deepening or replacement because of water-level change in response to changed water disposal practices on the core zone. As cleanup proceeds, modeling will continue to assist in the identification of monitoring well locations that are needed to detect and monitor plumes and to reduce uncertainty in the area between wells where measurements are not available.

5.2.2 Considerations for Near-Term Action

Hanford currently has an extensive groundwater monitoring program with results reported each year, most recently in *Hanford Site Groundwater Monitoring For Fiscal Year 2001* (Hartman et al. 2002). A number of near-term actions have been identified to improve the integration of monitoring performed to meet a number of site needs. Those actions include:

- Carry out the data quality objectives process for the core zone to coordinate and possibly integrate RCRA, CERCLA and AEA requirements.
- Examine decision road map for core zone to identify additional information needs that require monitoring.
- Develop a prioritized rolling three-year schedule for monitoring well installation.
- Establish a process to review and update the monitoring program.

5.2.3 Considerations for Final Monitoring Efforts

As the cleanup continues to reduce the potential for waste sites and site operations to affect groundwater, the Tri-Parties will continue to implement the process developed to review and update the groundwater monitoring program. Once protective measures and remedial actions are completed, contamination may be left in the vadose zone and the groundwater at levels that potentially exceed standards for protection of public health and the environment. Therefore, as these actions are completed, adequate monitoring must continue, not only of the groundwater and vadose zone, but also for the soundness of physical barriers and institutional controls that continue into the future.

5.3 Groundwater Remediation

The goal of groundwater remediation is to restore groundwater to its intended beneficial uses to protect human health, the environment, and the Columbia River. This strategy provides a common, sitewide perspective to guide the development of remediation activities for individual operable units. Guiding principles are developed within the context of existing groundwater conditions, the institutional and regulatory framework for remediation, and stakeholder values. These principles for a comprehensive groundwater remediation approach are summarized below.

5.3.1 Groundwater Remediation Framework

Characterization. The necessary characterization will be carried out to better understand the hydrogeology, contaminant behavior/chemistry, sub-surface conceptual model, contaminant inventory and its nature and extent, and to design and assess remedial actions where ever appropriate. Modeling results will be validated with actual field data. The field site will provide an opportunity to test advanced characterization tools and methods, identify mechanisms and processes that control the depth and extent of contaminant plumes in the Hanford Site vadose zone, and calibrate and refine predictive transport model.

As new information is obtained, estimates of actual or potential exposure and the associated effect on human health and the environmental may be refined throughout the remedial investigation. Therefore, site characterization activities will be fully integrated with the development and evaluation of alternatives in the feasibility study/remediation effort.

Risk Assessment. Remedial alternatives/goals shall establish acceptable exposure levels that protect human health and the environment. These alternatives shall be developed as called for under applicable and appropriate requirements in federal and state laws. Risk assessment will follow the standard protocol set for different site-use scenarios. Detailed assessment would include a number of site-specific land-use scenarios ranging from unrestricted, agricultural, tribal, and restricted scenarios such as industrial use. The assessment also would include quantification of the cumulative health and environmental effects of Hanford contaminants on ecology, human health, culture, and economy of the area. The goal is to meet the cleanup levels for highest possible beneficial use of groundwater through remediation and other appropriate measures.

Science and Technology. There is a long-term need for science and technology to support groundwater remediation on the Hanford Site. In some cases existing technologies are prohibitively expensive for long-term use and in other cases the knowledge and technology needed to address the problem does not yet exist.

Modeling and Assessment to Support Groundwater Remediation. Predictions of future movement of contaminants in groundwater play an important role in prioritizing, planning and evaluating the effectiveness of remediation actions. Models of the vadose zone and groundwater for individual waste sites are used to plan barrier location and size as well as design pump-and-treat systems and other remedies. Models representing multiple waste sites are used to help identify locations (e.g., B/C cribs and trenches, each tank within an individual tank farm, or multiple tank farms within an operational area, like all within 200 West Area) where active remediation will achieve the greatest benefit. Models used will be validated against real data to insure accuracy.

The remediation strategy is a geographic and plume-specific approach to groundwater remediation. It is oriented to reflect public and tribal values and priorities. The following are key elements of this strategy:

- Place a high priority on actions that protect the Columbia River and near-shore environment from groundwater degradation caused by the inflow of contaminated groundwater.
- Reduce the contamination entering the groundwater from existing sources.
- Control the migration of plumes that threaten or continue to further degrade groundwater quality beyond the boundaries of the core zone.
- Avoid recontamination of the sites undergoing groundwater remediation or further groundwater degradation from site operations.
- Develop a Hanford Site process to establish alternate concentration limits.

5.3.2 Initial Remediation Efforts

Groundwater remediation efforts are underway on the Hanford Site. These efforts:

- Maintain a bias toward field remediation activities by employing the Hanford Past Practice Strategy (Thompson 1991) to accelerate interim remedial actions.
- Continue implementation of accelerated groundwater remediation projects to control plume expansion, reduce contaminant mass, and better characterize aquifer response to remedial actions.
- Develop and evaluate alternative remediation technologies.

A number of characterization and assessment actions are underway at the Hanford Site to provide important data to evaluate and support remediation decisions. These actions will be completed prior to initiating any new actions in the same study area. Evaluation and update of existing groundwater remediation actions will continue under past-practice authority using interim records of decision that may be modified to accommodate new remediation technologies and characterization needs. Ongoing characterization actions for tank farms (supporting the field investigation reports) will be completed prior to revising the monitoring/assessment well networks for the corresponding waste management area.

Continued technology development is needed to identify alternate, more effective remediation techniques for existing groundwater contaminant plumes. Techniques to remove, remediate, and/or immobilize chromium, uranium, and technetium-99 in the vadose zone before reaching groundwater; reduce costs for existing remediation technologies; and characterization to understand natural degradation of carbon tetrachloride are examples of near-term science and technology needs. The science and technology roadmap (DOE/RL 2000) will continue to be used to link cleanup project needs to science and technology investigations.

5.3.3 Final Remediation Efforts

Succeeding phases of remedial actions are oriented toward identifying and implementing the final records of decision, which in turn will satisfy broader cleanup objectives, such as:

- Achieve applicable relevant and appropriate requirements with respect to the value of current and potential future beneficial uses for the groundwater resource.
- Develop alternative containment and remediation strategies if currently available groundwater restoration technologies prove inadequate or impracticable.
- Restore groundwater outside the core zone for unrestricted use, as soon as technically possible.
- Remediate groundwater in the river corridor with the focus on protecting human health and the environment.
- Prevent further degradation of groundwater quality beyond the boundaries of the core zone, and ultimately restore unrestricted use of groundwater beyond that boundary.
- Implement process to establish alternate concentration limits (ACLs) where required.

5.3.4 Resource Optimization

An important element in the groundwater remediation strategy is optimizing the use of available resources. The following are key considerations:

- Balance the sequencing and scale of remedial actions to achieve efficient use of resources.
- Incorporate existing and/or proposed treatment and disposal infrastructure.
- Implement currently available technology and foster demonstrations of developing technology for meeting remediation objectives.
- Improve the integration of the existing groundwater monitoring networks and sampling schedules, to better characterize the contamination problem and to measure the effectiveness of remediation efforts.
- Obtain information necessary to make decisions and speed up remediation of groundwater.
- Review DOE Orders to ensure they are relevant to the cleanup mission.

5.3.5 Remediation of Emerging Groundwater Plumes

EPA, DOE, and Ecology recognize the need to coordinate the application of regulatory requirements, and that past-practice authority may provide the most efficient means to address mixed-waste groundwater contamination plumes originating from a combination of treatment, storage, and disposal units and past-practice units. There is a need to coordinate remedial actions, whenever feasible, at CERCLA operable units with adjacent operable units, with RCRA facilities undergoing closure, and with state-permitted waste discharge facilities. Groundwater response actions for which EPA is the lead regulatory agency shall assure compliance with the technical requirements of RCW 70.105. Notwithstanding this operating assumption, Ecology reserves the right to exercise its authority under RCW 70.105 to require groundwater remedial actions specific to the treatment, storage, and disposal units.

6.0 Implementation

This document presents the general strategy for groundwater protection, monitoring, and remediation. There are two key aspects to implementing this strategy: (1) technical and regulatory documents outlining the details of specific groundwater protection, monitoring, and remediation actions and (2) communication of plans and results to Tribal governments, stakeholders and the public.

6.1 Implementing Documents

This document identifies the high-level strategies for groundwater protection, monitoring, and remediation for the Hanford Site. As such, this document is not intended to provide specific groundwater protection, monitoring, or remediation details, nor is it intended to be legally binding on the Tri-Parties. Specific actions necessary to implement these high-level strategies will be carried out through individual legally-binding decision documents and several subordinate policy-level documents.

The Tri-Party Agreement (Ecology et al. 1998) is the primary legal document that provides schedules and requirements to achieve compliance with applicable regulatory requirements and to clean up the Hanford site. Generally, the Tri-Party Agreement relies on program-specific decision documents, such as the RCRA site-wide permit and CERCLA decision documents (including 5-year reviews of records of decisions) to develop and approve work necessary to implement this strategy and satisfy regulatory requirements. In other instances, such as where waste management units cannot operate in compliance with applicable regulatory standards (for example, single-shell tanks), the Tri-Party Agreement defines schedules of specific actions necessary to achieve compliance and mitigate the effects of non-compliant activities. In all cases, specific requirements that implement this groundwater strategy will be subject to public notice and comment according to the program-specific administrative approval requirements associated with each decision document or the Tri-Party Agreement.

The following strategy/plan documents provide additional strategy, policy or procedures that relate to the overall strategy of this document:

- The groundwater remediation strategy (DOE/RL 1995)
- The annual project planning process carried out each year.
- Groundwater monitoring plans (e.g., *FY 2002 Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project*, PNNL-13698).
- The *Hanford Site Groundwater Monitoring Setting, Sources and Methods* (Hartman 1999)

- Hanford Site groundwater monitoring reports (e.g., *Hanford Site Groundwater Monitoring for Fiscal Year 2001*, Hartman et al. [2002])
- A Central Plateau wide study of the vadose zone to provide guidance on when vadose zone monitoring is appropriate.

It is the intent of the Tri-Parties that the strategies set forth in this document and the various supporting strategy/policy documents enumerated above be reflected in final enforceable decision documents and Tri-Party Agreement milestones and requirements. The Tri-Parties further anticipate that the strategy and planning documents enumerated above be updated as necessary to be consistent with this strategy document.

6.2 Communication of Plans, Progress, and Results

The Tri-Parties recognize the importance of communicating the plans and results of groundwater actions to Tribal governments, stakeholders and the public. Transparency and accessibility lead to more effective public participation in protecting, monitoring, and remediating Hanford groundwater. Improved understanding of the issues, challenges, and options will lead to better decisions and to credibility for the agencies responsible for making those decisions.

The communication strategy that will be implemented to support these goals will involve the use of a diverse range of activities and products to provide information to and elicit input from these organizations and individuals about Hanford groundwater actions. Examples of communication mechanisms that may be used are regular public meetings, internet-accessible information, articles in general and technical publications, electronic newsletters, and informational compact discs. Specific detailed communication planning is underway.

7.0 Review and Evaluate

This strategy will be reviewed annually to determine if it remains consistent with long-range goals of the Tri-Parties. Appendices that include detailed protection, monitoring, and remediation actions will not be updated. These details will be updated as annual work plans are developed.

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Appendix A

Completed, Baseline, and Accelerated Actions that Implement the Groundwater Strategy

Appendix A

Completed, Baseline and Accelerated Actions that Implement the Groundwater Strategy

This appendix summarizes completed work, actions included in baseline plans, and accelerated actions included in the *Performance Management Plan for Accelerated Cleanup of the Hanford Site* (DOE/RL 2002). The accelerated actions most closely related to groundwater protection, monitoring, and remediation are Initiatives 5 and 6. In addition, several accelerated actions have been identified for Science and Technology development. Table A.1 provides a crosswalk between the groundwater strategy elements and elements of the *Performance Management Plan for Accelerated Cleanup of the Hanford Site* (DOE/RL 2002).

The actions that implement the groundwater strategy have been organized into three broad categories for the purpose of managing the work. Those categories include: groundwater protection, groundwater monitoring, and groundwater remediation.

Table A.1. Groundwater Strategy Links to Performance Management Plan for Accelerated Cleanup (DOE/RL 2002)

	Groundwater Strategy Element	Performance Management Plan for Accelerated Actions Initiative Element
Groundwater Protection	Operation of waste storage and disposal facilities	
	Removal or immobilization of contaminant sources	Initiative 5 - U-Plant regional closure Initiative 6 - Shrink the footprint Initiative 6 - High risk waste sites
	Reducing natural and artificial recharge in contaminated areas	Initiative 6 - Reduce infiltration at existing waste sites Initiative 6 - Repair of leaking water lines Initiative 6 - Elimination of U Plant septic system discharge
	Decommissioning unnecessary wells	Initiative 6 - Decommissioning of wells
Groundwater Monitoring	Detect groundwater impacts from operating and past practice waste sites Determine the nature and extent of groundwater contamination so that appropriate action can be taken Assess the effectiveness of groundwater remediation activities Verify that Hanford Site contaminants are not present in offsite groundwater	Initiative 6 - Installation of wells to create an integrated sufficient monitoring well network within three years
Groundwater Remediation	Initial remediation efforts Final remediation efforts	Initiative 6 - Accelerate actions to get final remediations in place

A.1 Groundwater Protection

The elements of groundwater protection discussed in this appendix are:

- Operation of waste management and disposal facilities
- Managing surface water
  - -- Run-on control
  - -- Well abandonment
  - -- Elimination of leaking water lines
  - -- Discontinue use of septic tanks in the vicinity of waste sites
- Waste site remediation
- Monitoring

A.1.1 Operation of Waste Storage and Disposal Facilities

A number of facilities are operated at Hanford to store and dispose of waste generated in the past as part of Hanford operations and currently through the activities underway to clean up the site. Hanford's Waste Management Project operates the following facilities at Hanford:

- Central Waste Complex—to store waste.
- Waste Receiving and Processing Facility—to examine and evaluate transuranic and low-level waste and prepare transuranic waste for shipment to the Waste Isolation Pilot Plant in New Mexico.
- T Plant—to decontaminate and prepare K-Basin sludge.
- Waste Encapsulation and Storage Facility—to store cesium and strontium capsules underwater.
- Liquid Effluent Facilities (242-A Evaporator, Liquid Effluent Retention Facility, Effluent Treatment Facility, Treated Effluent Disposal Facility)—to treat and dispose of liquid effluents.
- Burial grounds—to dispose of solid waste.

Facilities are operated by the Waste Management Project to protect the environment. Protection is provided by:

- Facility design, such as liners and leachate collection systems on appropriate facilities and monitoring systems to guard against leakage.
- Waste acceptance criteria that limits what waste can be accepted for treatment, storage, or disposal.
- Performance assessment documentation that analyzes the behavior of disposed waste on the environment, including groundwater.
- Facility operating permits (Resource Conservation and Recovery Act of 1976 [RCRA], Clean Air Act [CAA], Clean Water Act [CWA]) that specify operating and other conditions that protect the environment.
- Procedures, including those for facility operation as well as response to conditions such as spills.

In addition, the Environmental Restoration Disposal Facility is operated at Hanford to receive and isolate low-level radioactive, hazardous, and mixed waste. It is authorized by the U.S. Environmental Protection Agency (EPA) to receive only waste from Hanford cleanup activities. The Environmental Restoration Disposal Facility is located in the center of the Hanford Site between the 200 East and 200

West Areas. The Environmental Restoration Disposal Facility is a large-scale, evolving landfill, complete with ancillary facilities. The facility is a RCRA-compliant landfill that is authorized under Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). The facility also complies with all appropriate requirements, including Washington State Department of Ecology (Ecology), EPA and U.S. Department of Energy (DOE) codes, orders, standards and regulations. The Environmental Restoration Disposal Facility is designed to provide disposal capacity, as needed, to accommodate projected Hanford waste volumes over the next 20 to 30 years.

Four disposal cells make up the Environmental Restoration Disposal Facility. The first two cells are each 70 feet deep, 500 feet long and 750 feet wide. Construction of two additional cells was completed in 2000. An interim cover was placed over the filled portions of the first two cells. Design and construction of the final cover will not begin until cells #3 and #4 are filled. The Environmental Restoration Disposal Facility can be expanded further if necessary. Capacity of the current four-cell configuration is ten million tons. The cells are lined with a RCRA Subtitle C-type liner and have a leachate collection system. The facility is monitored regularly and when closed will continue to be monitored to ensure that human health and the environment are protected.

A.1.2 Managing Surface Water

This activity implements the strategy element "Reducing Natural and Artificial Recharge."

Infiltration of water to the vadose zone provides the driving force for downward migration of contaminants in the vadose zone at the Hanford Site. Water in the vadose zone may come from such things as natural precipitation, waste water disposed to cribs, leaks from tanks, leaking water lines, septic tanks, and drain fields.

Efforts to reduce recharge started in earnest in 1987, as plans were developed to discontinue disposal of liquid waste streams to the soil. Over the next 2 years, the number of liquid waste streams was drastically reduced, and waste streams containing radioactive contaminants were routed through the 200 Area treatment facility in compliance with the Tri-Party Agreement milestone M-17 (Ecology et al. 1998). Cooling water discharge to ponds and ditches also was reduced and eventually eliminated on the Central Plateau as the decommissioning of PUREX was completed and other processes were shut down. These actions have nearly eliminated the disposal of wastewater on the Central Plateau. The focus of baseline and accelerated actions are on eliminating the inadvertent and natural recharge to further protect Hanford's groundwater.

In 1998, DOE's Office of River Protection initiated a program to reduce natural and artificial recharge in and around tank farms to reduce the potential for contaminants in the vadose zone to be carried to groundwater. The program has four major components:

- Design and construct surface water run-on control measures upgradient of single shell tank farms.
- Abandon leaking pressurized water lines adjacent to single-shell tank farms.
- Upgrade monitoring drywells at single-shell tanks to include leak tight caps.
- Install surface cover for stabilization purposes.

Actions to reduce natural and artificial recharge were completed during fiscal year 2001 for 200 West Area tank farms. Actions for 200 East Area tank farms will be completed in 2002. The installation of prototype surface barriers to stabilize tank farm surfaces is planned for 2003.

Accelerated actions to reduce infiltration are proposed in the *Performance Management Plan for Accelerated Cleanup of the Hanford Site* (DOE/RL 2002) under Initiative 6 and include four key actions:

- Reduce infiltration at existing waste sites.

- Decommission wells.
- Repair leaking water lines.
- Eliminate U Plant septic system discharge.

Actions to be taken to reduce infiltration at existing waste sites will be similar to the actions being completed in and around tank farms. Berms will be constructed to prevent surface water from flowing onto waste sites, and areas around waste sites will be graded to allow snowmelt and other precipitation to run off the sites rather than infiltrate. This action can be completed by the end of 2005.

Wells that do not meet regulatory standards for construction will be eliminated to reduce the potential for them to act as a pathway for contaminated water to reach the groundwater. Ninety-nine wells were decommissioned during fiscal year 2001. Well decommissioning is not currently in the Hanford baseline; however, an accelerated action has been proposed to decommission high-risk wells by 2006 and the remaining wells by 2018.

Accelerated actions related to the treatment of Hanford's water lines has several components. It includes eliminating water lines near waste sites when possible and testing them to ensure they are not leaking when they cannot be eliminated. In addition, the site water supply system pumps will be changed to reduce water line pressure so that leaks are less likely to occur and less water will be lost if they do.

Septic systems continue to be used in the 200 Areas. One of those, the U Plant septic system, is located near radioactive waste disposal facilities that were used in the past. Under Initiative 6 of the performance management plan, discharge to this system will be eliminated by September of 2004. Other systems will be evaluated and any further actions will be identified by September 2004.

A.1.3 Waste Site Remediation

This activity implements the strategy element "Removal and Immobilization of Contaminant Sources." During the past 7 years the Environmental Restoration Contractor has cleanup up 237 waste sites to regulatory standards. A total of 3.2 million tons of contaminated material has been removed from sites near the Columbia River and 1.4 billion gallons of contaminated groundwater have been pumped from the ground and treated. In the process, all liquid waste disposal sites in the 100-D and 100-H Area were backfilled, and the highly contaminated 116-N-3 crib was demolished and the material disposed of.

Baseline plans for waste sites along the Columbia River are to complete remediation by 2012 through the River Closure contract.

Remediation of Central Plateau waste sites and other sites not included in the River Closure Contract is planned for completion by 2026. This baseline plan is substantially accelerated through the actions proposed in the Performance Management Plan for Accelerated Cleanup of the Hanford Site.

Accelerated actions proposed in the performance management plan for DOE/RL 2002) under Initiative 5 include developing a plan to optimize the timing and sequencing for disposition of excess facilities and remediation of waste sites that pose the highest threat to groundwater by May 2003, and implementation of the U Plant record of decision by December 2003. Remediation of U Plant waste sites, demolition of the canyon facility, and installation of covers would be completed by September 2011. A plan also will be developed for the proposed disposition of the remaining four canyons by September 2008.

Initiative 6 proposes to accelerate the remediation of high-risk waste sites including the BC cribs and trenches that contain a significant inventory of technetium-99 (over 600 Curies), the Plutonium Finishing Plant cribs that contain plutonium and carbon tetrachloride, and the PUREX cribs that received iodine-129 which has impacted groundwater. The primary remediation to be applied to these sites is the installation of surface barriers to reduce the infiltration of water that drives contaminants through the soil to the groundwater. Barriers will be constructed to specifications jointly established with the regulatory agencies. In some cases, barriers will be applied to sites as they are; in others, waste materials may need to be removed, treated, and disposed of. Accelerated actions on these high-risk waste sites are scheduled for completion by 2010.

Initiative 6 also proposes to accelerate the remediation of several waste sites that reside outside the Central Plateau so that the Hanford Site outside the Central Plateau can be released for other uses as soon as possible. This includes remediation of Gable Mountain Pond, B-Pond, 200 North and several landfills. All waste sites outside the core zone with the exception of the 618-10 and 618-11 burial grounds are scheduled for remediation by the end of 2012 instead of 2026, as is the current baseline.

A.2 Groundwater Monitoring

DOE has monitored groundwater on the Hanford Site since the 1940s to help determine what chemical and radiological contaminants have made their way to groundwater and how they have migrated in groundwater. As regulatory requirements for monitoring increased in the 1980s, there began to be some overlap between various programs. DOE established the Hanford Groundwater Monitoring Project in 1996 to ensure protection of the public and the environment while improving the efficiency of monitoring activities. The project addresses all groundwater monitoring needs at the site, eliminates program redundancy, and allows for cost-effective groundwater monitoring activities.

The Hanford Groundwater Monitoring Project provides groundwater monitoring, assessment, and reporting to meet the requirements of RCRA, CERCLA and the Atomic Energy Act of 1954 as implemented by DOE Orders. The Groundwater Protection Program provides the groundwater monitoring, assessment, and reporting for groundwater operable units where active groundwater remediation is ongoing. The program provides an integrated, site wide assessment of groundwater quality and impacts from waste-disposal facilities operated by DOE and its contractors.

Both the unconfined and upper-confined aquifers are monitored and data are maintained and managed in a centralized database. Monitoring well locations, frequencies, and analytical constituents are documented each year. Sampling and analysis is coordinated among all data users, and results are evaluated to describe the areal extent and temporal trends of contamination. Results and conclusions are reported in a quarterly electronic report for RCRA facilities and are described in detail in an annual groundwater monitoring report for the entire site that meets all objectives and regulatory requirements. Results are summarized in the Hanford Site environmental report (Poston et al. 2002).

Water-level monitoring is performed to characterize groundwater flow and to determine the impact of Hanford Site operations on the flow system. The unconfined aquifer has been characterized in the past to construct and update a three-dimensional conceptual model for the unconfined aquifer. This conceptual model forms the basis for a numerical flow and transport model that has been constructed and used to predict impacts of site operations on groundwater flow and groundwater quality. These predictions are used to assess potential impacts and offsite migration.

Groundwater monitoring remains a part of the Hanford baseline throughout the cleanup mission at the site and will remain a component of long-term stewardship after remediation is completed.

One aspect of the groundwater monitoring program included in the performance management plan (DOE/RL 2002) is the installation of wells to create an integrated sufficient monitoring well network within three years. During 2002, a team of Ecology, EPA, DOE, and contractor staff participated in a data quality objectives process to identify the additional wells needed to adequately monitor the Central Plateau. That process identified a number of wells that along with those already in existence would satisfy the regulatory requirements of CERCLA, RCRA, and the Atomic Energy Act of 1954. Installation of 200 West Area wells by can be completed by October 2003, 200 East Area wells by October 2004, and other needed wells in the Central Plateau by October 2005.

A.3 Groundwater Remediation

Groundwater remediation is underway at a number of locations on the Hanford Site. Records of decision call for active pump-and-treat systems at some locations and active monitoring of the attenuation of contaminant plumes that occur naturally at others where these processes are anticipated to be sufficient or where active remediation technologies are not available. These actions are briefly described below.

100-HR-3 and 100-KR-4 Operable Units. Groundwater beneath the 100-D, 100-H, and 100-K Areas was determined to represent an imminent risk to aquatic life in the Columbia River. An interim action to control the release of hexavalent chromium to the river through seeps and springs was initiated. This action was to install and operate a pump-and-treat system to reduce the concentration of chromium in the aquifer. These plumes as well as many of the seeps and springs exceed the aquatic water quality criteria. The remedial actions for these actions are based on the aquatic water quality criteria with an appropriate dilution factor for the interaction between the ground and surface waters based on extensive sampling within the seeps and springs.

An amendment to the decision for the 100-HR-3 Operable Unit was issued to deploy an alternative to pump-and-treat using a permeable barrier to chemically reduce the toxic chromium to a less toxic form. Installation of this barrier the 100-D Area will be completed in 2002.

100-NR-2 Operable Unit. Interim actions were taken to control the release of strontium-90 to the Columbia River in the 100-N Area. Although the actions taken were to address imminent risk, the remedial objectives for this action appear to be more along the lines of containment and mass reduction. No aquatic water quality criteria standards exist for Strontium-90, but concentrations entering the river exceed drinking water standards by more than 1,000 times.

Efforts are underway between DOE and Ecology to move this action to a more containment-based remedy using a sorptive barrier. Source control actions are nearly complete, but it is likely deep vadose zone contamination will necessitate restricted use for the final action.

200-UP-1 and 200-ZP-1 Operable Units. Containment and mass reduction interim actions are underway to limit future degradation of groundwater outside the boundaries of the Central Plateau due to uranium and technetium-99 from 200-UP-1 Operable Units and from carbon tetrachloride contamination from the 200-ZP-1 Operable Units. Pump-and-treat systems were initiated in these locations due to the elevated concentrations of these contaminants in the groundwater and the massive inventory of these substances that remain unaccounted for in the vadose zone.

While interim remedial actions are underway at these sites, Initiative 6 proposes accelerated actions to get final remedies in place as soon as possible. This involves completing field investigations at the 200West Area carbon tetrachloride site by June 2004 so that the information is available to make a final decision. Alternative remedial technologies, such as phytoremediation, for strontium-90 at 100-N Area will be evaluated and deployed if appropriate by January 2006, and an apatite barrier will be deployed at 100-N springs if appropriate by October 2007.

A.4 Science and Technology

The Hanford Science and Technology Project was initiated in 1998 as part of the Groundwater/Vadose Zone Integration Project with the goal of coordinating and performing scientific research to support decision making for remediation activities at Hanford. The Science and Technology Project is now part of the Groundwater Protection Program at the Hanford Site and consists of focused, site-specific investigations funded by DOE Richland Operations.

The Science and Technology Project uses the process of road mapping, where problem holders (such as the DOE, Tribal Nations, regulators, stakeholders, and remediation contractors) come together with problem solvers (such as scientists and engineers from universities and the DOE national laboratories) to define the problems and establish a path to solution. The scope and outcomes of Science and Technology activities, linkages of outcomes to the Groundwater Protection Program or other Hanford Site projects, and the schedule, budget, and priorities for these activities are documented in the Science and Technology roadmap, which was issued and revised twice (DOE 1999; DOE 2000). The Science and Technology Project, and specifically the roadmap, was reviewed during FY00 and FY01 by a National Academy of Sciences/National Research Council committee, which issued a report on their findings (NRC 2001).

Major accomplishments of the Science and Technology Project to date include:

- Completing development of the soil inventory model to derive waste inventories and uncertainties for contaminated soil sites in the 200 Areas, used in the sitewide assessment with the System Assessment Capability.
- Incorporating research results from the Science and Technology Project and EMSP directly into the Field Investigation Report for the S-SX Tank Farm, a Tri-Party Agreement mandated milestone dealing with tank farm corrective actions (RPP 2002). Work is now underway focused on investigations of the B-BX-BY tank farm.
- Completing field experiments in the 200 East Area with dilute and saline solutions and tracers, showing that subtle changes in sediment texture can induce lateral spreading of moisture plumes and contaminants in the vadose zone (Gee and Ward 2001).
- Completing development of conceptual and numerical models of the groundwater/river interface at 100-H Area and other reactor areas.
- Completing biological fate and transport experiments involving technetium-99 uptake in fish and an aquatic plant.

The Science and Technology roadmap is currently undergoing revision to reflect accomplishments to date, comments by the National Academy of Sciences committee, and to add the soil and groundwater remediation technical element. Activities in the roadmap are linked to the performance management plan's (DOE/RL 2002) Initiative 5 for Central Plateau regional closures and Initiative 6 for groundwater protection. The groundwater protection activities include scientific investigations and technology development to upgrade current groundwater pump and treat systems operating at the site. Future revisions of the roadmap will reflect additional accomplishments, changes in the site baseline, and will include the monitoring technical element.

Activities proposed for FY03 through FY05 as part of the Groundwater Protection Program, DOE EM-50, and EMSP include:

- Complete development and application of the soil inventory model to estimate inventories for past practice soil waste sites to support sitewide assessments.
- Perform vadose zone moisture and water flux measurements to support U Plant regional closure and other groundwater protection measures.
- Complete uranium reactive transport field experiment and data analysis, including scaling of modeling parameters.
- Complete laboratory and modeling studies for T-TX-TY Tank Farm and remedial design at environmental restoration sites PW-1, TW-2, and CW-5 and initiate studies for A/AX, C, and/or U tank farms; integrate EMSP studies of uranium and strontium-90.

- Complete carbon tetrachloride laboratory studies and model development (Groundwater Protection Program), complete carbon tetrachloride characterization and remediation acceleration project (DOE EM-50) and integrate carbon tetrachloride retention and release and in situ remediation studies (EMSP).
- Complete biological fate and transport studies of strontium-90 and uranium and initiate iodine-129 studies to support sitewide assessments and remedial decisions.
- Perform remediation technology development studies to address phytoremediation and apatite sequestration of strontium-90 (Hanford Site Strategic Initiative 6), bioremediation of technetium-99 and chromium (DOE Natural and Accelerated Bioremediation Research Program), carbon tetrachloride in the vadose zone and groundwater, and surface barrier development.

Accelerated sections proposed in performance management plan (DOE/RL 2002) include committing EM-50 or incremental additional site funding for science and technology initiatives required to support remedial decisions for the 618-10 and 618-11 burial grounds by October 2002. Accelerated actions also were identified to commit EM-50 or incremental additional site funding for science and technology initiatives required to support remedial decisions for the 200-ZP-1 Operable Unit (carbon tetrachloride) and initiatives required to support remedial decisions for 100-N Springs. The additional funding for these two activities is to be committed by October 30, 2002.

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RCRA – Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

Appendix B

Decisions Related to Groundwater Remediation

Appendix B

Decisions Related to Groundwater Remediation

The following tables identify the decisions related to groundwater remediation that need to be made for each area on the Hanford Site. The tables also include the date each decision must be made, the information needed to make the decision, and any pertinent comments.

Table B.1. 100 Area Decisions

Location	Decision	Date	Information Needs	Comment
100-N Area	Interim groundwater decision	2004	Evaluate remediation alternatives and strontium - 90 impact on river receptors - currently 2004, could be expedited to 2003 to support groundwater decision.	Source removal (DOE baseline) not expected to protect groundwater.
100-B/C Area	Groundwater Remediation	2007	Contaminant concentrations in groundwater after source removal complete.	Natural attenuation or active remedial action.
100-F Area	Groundwater Remediation	2009	Contaminant concentrations in groundwater after source removal complete.	Natural attenuation or active remedial action.
100-H Area	Groundwater remediation	2010	Contaminant concentrations in groundwater after source removal complete.	Natural attenuation or active remedial action, Need to consider 183-H solar evaporation basins in decision.
100-D Area	Groundwater remediation	2012	Contaminant concentrations in groundwater after source removal complete.	Natural attenuation or active remedial action.
100-K Area	Groundwater remediation	2013	Contaminant concentrations in groundwater after source removal complete.	Natural attenuation or active remedial action.

Table B.2. 200 East Area Decisions

Location	Decision	Date	Information Needs	Comment
PO-1	Final remediation	2026	Impact of source removal of PO-1 area	
	Near term actions	2003	Monitoring Plan	The **RFI/CMS** is drafted, need to resolve the RCRA/CERCLA policy issue and then use this document to set up monitoring system until final decision in 2005 tank farm investigation of soil to be completed, 2007 ORP to complete FIRs
BP-5	Monitoring Plans	2007	Field Investigation Reports (FIRs) for Tank Farms	
		2003	Monitoring Plan	Active investigation complete for major plumes
	Final remediation	2026	Impact of source removal in BP-5 area	

Table B.3. 200 West Area Decisions

Location	Decision	Date	Information Needs	Comment
200-W				
UP-1	Modification of remediation approach	2005	Focused Feasibility Study, Alternate remedial technologies for uranium, Remedial action report	MSE Technologies is developing a geochemical model for uranium in the vadose zone and groundwater at UP-1. The model will be developed in FY 2002, 2003 and a final report is scheduled for FY 2004. The geochemical model will facilitate the evaluation of alternate remedial technologies for uranium
			Alternate remedial technologies for uranium	
			Remedial action report	
	Decide if we have met goals and what the next steps are	2006	Inventory and information from above listed studies	Evaluate how well goals have been met, evaluate technical improvement, evaluate practicability
			Liquid effluent treatment capacity	If Waste Treatment Plant takes all the Effluent Treatment Facility capacity may need to build new facility
ZP-1	Decide on path forward with selected remedy	2008	RI/FS, Source information	Invest money now to evaluate our system
		2005	RI/FS work plan	
		2006	Source identification completed	

Table B.4. 300 Area and 1100 Area Decisions

Location	Decision	Date	Information Needs	Comment
300 Area	Interim groundwater decision	2006	Need to determine impacts (ecological) of uranium on river	Next 5 year review is critical
	Monitored Natural Attenuation	2006	MNA re-evaluation	Monitored Natural Attenuation (MNA) was selected as the interim action remedy prior to 1999 DOE guidance on MNA and EPA OSWER Directive 9200 4-17P
1100 Area	Decide to stop monitoring	2006	Monitoring results remain below MCL	

Appendix C

Additional Regulatory Background Information: Role of RCRA Corrective Action for Groundwater

Appendix C

Additional Regulatory Background Information: Role of RCRA Corrective Action for Groundwater

The Resource Conservation and Recovery Act (RCRA) and Washington State Dangerous Waste Programs have two key corrective action programs relating to clean up of releases to the environment. The first, and more traditional, relates to releases to groundwater from land-based "regulated units," defined as landfills, land treatment units, and surface impoundments. This program element, which is an integral part of required groundwater monitoring under 40 CFR 264, Subpart F and WAC 173-303-645, is limited to releases to groundwater from these specific types of units. This authority does not apply to other types of units or to releases to any other environmental media. In re-authorizing RCRA in 1984 through the Hazardous and Solid Waste Act amendments, Congress added the second corrective action program element, now more broadly known as the RCRA corrective action program. This authority has several notable elements. First, it is statutorily required of all permitted facilities to protect human health and the environment. Second, it applies to solid waste management units, a scope well beyond the limited applicability of 40 CFR 264, Subpart F groundwater corrective action. Third, it applies to releases to all media, not just releases to groundwater. Finally, it may be satisfied by specific permit conditions or by schedules of compliance where necessary work cannot be completed by the time of issuance of the permit.

How do these two corrective action program elements relate to one another? Generally, releases to groundwater from "regulated units" (in the 40 CFR 264, Subpart F context) must be addressed through the groundwater monitoring requirements of Subpart F and WAC 173-303-645. Because these types of releases are most closely associated with the waste management component of RCRA, the choice between the applicable Subpart F and the Hazardous and Solid Waste Act corrective action requirements is strongly biased to the preventative waste management standards of 40 CFR 264, Subpart F. The one key exception to this interpretation is land-based units that are closed or closing and subject to post-closure care requirements. In this instance, the groundwater monitoring requirements of 40 CFR 264, Subpart F and WAC 173-303-645 may be replaced with equally protective requirements developed through the Hazardous and Solid Waste Act corrective action process.

Under terms of the Hanford Tri-Party Agreement (Ecology et al. 1998), cleanup responsibilities are allocated to the authorities of RCRA and CERCLA, and oversight by the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology. In a number of instances, both agencies and both programs have jurisdiction over the same waste management unit. A specific example is a solid waste management unit subject to corrective action under WAC 173-303-646, and under the cleanup authorities of CERCLA. The clear intent of both the Tri-Party Agreement and the sitewide permit is to minimize duplication and overlap of regulatory activities while assuring full compliance with applicable requirements.

Where particular corrective action conditions under the authority of WAC 173-303-646 are not explicitly included in the sitewide permit (either condition II.Y.3 or Part IV), permit condition II.Y.2 addresses this question of overlapping jurisdiction. Generally, this condition recognizes and accepts as potentially satisfying the corrective action requirements of WAC 173-303-646 work completed (including schedules of compliance) under the Tri-Party Agreement for both CERCLA and RCRA past-practice units. This condition requires the permittee to comply with the terms and schedules in the Tri-Party

Agreement for each of these units. Permit conditions II.Y.2.a and II.Y.2.b accomplish this end by including Tri-Party Agreement requirements and schedules applicable to CERCLA and RCRA past-practice units into the sitewide permit by reference, including amendments to the Tri-Party Agreement after the effective date of these permit conditions. As documents developed and approved under the Tri-Party Agreement, CERCLA records of decision also are included in this provision as documents developed and approved under the Tri-Party Agreement. In this way, the permit explicitly exercises and satisfies the corrective action requirements of WAC 173-303-646 while fully meeting the objective of minimizing or elimination duplication and overlap between programs and agencies. In no way does this mechanism waive or provide any relief from any applicable RCRA or CERCLA requirement.

Permit condition II.Y.2.c also recognizes the overlap between the RCRA closure/postclosure requirements and corrective actions. This condition allows the permittee to satisfy applicable corrective action requirements through the closure/post-closure care process. Although both EPA and Ecology policy and guidance acknowledge that closure and corrective action should achieve similar environmental outcomes, this condition anticipates that the RCRA closure process should be principle regulatory mechanism for dealing with environmental releases at the time of unit closure.

C.1 Summary of Unit Classifications at Hanford

Units at Hanford subject to groundwater monitoring requirements can be divided into several general classes. The first includes land-based units currently operating and receiving regulated dangerous/mixed waste. For these units, the primary regulatory focus is the preventative waste management component of RCRA, specifically the traditional detection/compliance monitoring and groundwater corrective action requirements of WAC 173-303-645. Presently, units in this class include the mixed waste trenches 31 & 34, the Liquid Effluent Retention Basins , and through the CERCLA program, the Environmental Restoration Disposal Facility. These units all have, or are scheduled to receive, RCRA operating permits (or CERCLA authorization in the case of the Environmental Restoration Disposal Facility). As waste management units, this class of regulated units is expected to be well designed, constructed, and operated to prevent releases to the environment, including groundwater, that require cleanup.

The second class includes closed/closing land-based units that are identified as RCRA treatment, storage, and disposal units in Appendix B of the Tri-Party Agreement (Ecology et al. 1998), but are no longer actively receiving regulated waste. This class of units includes traditional landfills or burial grounds, as well as other units like cribs or trenches. These units are scheduled to begin the closure/post-closure process and will not receive RCRA operating permits. These units also are subject to the traditional groundwater monitoring requirements of WAC 173-303-645, but may also be eligible for provisions that allow groundwater and closure requirements to be developed through the corrective action process under the authority of WAC 173-303-645(1)(e). When this regulatory provision can be applied,[1] it is possible to satisfy applicable RCRA regulatory requirements for the regulated unit through equally protective requirements developed under CERCLA authority.

The third class of units includes single-shell tanks. Single-shell tanks are not regulated as land-based units under WAC 173-303-645 (see specifically the definition of "regulated unit" in WAC 173-303-040), although contaminated soil associated with single-shell tanks may require closure as a landfill under the tank closure requirements of WAC 173-303-640(8)(b). Rather, single-shell tanks are non-compliant tank systems that cannot receive operating permits for storage of dangerous/mixed waste. As such, these units are addressed by compliance requirements and schedules of Tri-Party Agreement

[1] Other applicability criteria include (1) a demonstration that the regulated unit is situated among other solid waste management units or areas of concern, (2) a release has occurred, and (3) both the regulated unit and one or more of the solid waste management units or areas of concern are likely to have contributed to the release. In addition, it is necessary to apply the traditional groundwater monitoring and closure requirements in order to protect human health and the environment. See specifically WAC 173-303-645(e)(i) and (ii).

milestone M-45, including retrieval of waste, and the development and implementation of closure plans[2]. Due to the special regulatory status of single-shell tanks , all groundwater monitoring and response actions should be within the integrated, long-term management approach set forth in Tri-Party Agreement milestones M-45 and the associated monitoring requirements of M-24.

The final class of units are RCRA and CERCLA past-practice units scheduled under the Tri-Party Agreement Appendix C to be addressed under the CERCLA or RCRA corrective action process. RCRA and CERCLA achieve similar environmental endpoints with respect to protecting groundwater. Therefore, it may be appropriate for corrective action decisions at RCRA past-practice units to defer the groundwater component of a cleanup to a CERCLA operable unit, or to accept work conducted under CERCLA authority as satisfying RCRA corrective action requirements. This latter mechanism is fully developed as part of RCRA sitewide permit condition II.Y.2.

C.2 Single-Shell Tank Site Characterization and Monitoring

Single-shell tanks are non-compliant tank systems that, for many technical reasons, cannot be removed from service at this time. Tri-Party Agreement milestones associated with single-shell tanks provide a schedule of compliance for these tanks, including specific measures such as groundwater monitoring requirements that are necessary to minimize the environmental harm of continued management of waste in single-shell tanks and to build the necessary technical database to support retrieval and closure. The single-shell tanks are addressed by compliance requirements and schedules of Tri-Party Agreement milestones (e.g., M23, M41, M44, M45) that include actions on the retrieval of waste, development and implementation of RCRA corrective actions, closure plans, and post-closure monitoring. The single-shell tank monitoring would, therefore, include both vadose zone and groundwater characterization to detect contaminant sources in the vadose zone and groundwater and to delineate the nature of extent of contamination in both media so the necessary data needs are met to support waste retrieval, RCRA corrective actions, closure and post-closure monitoring. These activities will be carried out though various Tri-Party Agreement milestones as discussed in the preceding paragraphs. Wherever feasible, the characterization, monitoring, and corrective actions will be integrated on a sitewide basis to benefit other programs (e.g., CERCLA) and to provide cost efficiencies.

C.3 References

40 CFR 264, Subpart F. U.S. Environmental Protection Agency. “Releases from Solid Waste Management Units.” *U.S. Code of Federal Regulations.*

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act. 1980. Public law 96-150, as amended, 94 Stat. 2767, 42 USC 9601 et seq.

Ecology - Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1998. *Hanford Federal Facility Agreement and Consent Order*. Document No. 89-10, Rev. 5 (The Tri-Party Agreement), Olympia, Washington.

Hazardous and Solid Waste Amendments of 1984. 42 USC. § 6924 et seq.; 40 CFR. § 260.1 et seq. and 40 CFR. § 280.10 et seq.

RCRA – Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

WAC 173-303-040. *Definitions.* Washington Administrative Code, Olympia, Washington.

WAC 173-303-645. *Releases from Regulated Units.* Washington Administrative Code, Olympia, Washington.

[2] Formal approval of closure plans will be under the permit modification authority of WAC 173-303-800, pursuant to requirements of the TPA Action Plan [reference?] Section 5.3.

WAC 173-303-646. *Corrective Action*. Washington Administrative Code, Olympia, Washington.

WAC 173-303-800. *Permit Requirements for Dangerous Waste Management Facilities.* Washington Administrative Code, Olympia, Washington.

Appendix D

Supplemental Information Developed in Support of the Groundwater Strategy

Appendix D

Supplemental Information Developed in Support of the Groundwater Strategy

Basis of Agreement

The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) (i.e., the Tri-Parties) have noted a number of areas of agreement that provide a basis to develop a groundwater strategy:

1. The Tri-Parties desire to achieve a durable, agreement with common values that will allow for further planning.
2. The Tri-Parties recognize that monitoring for the *Resource Conservation and Recovery Act* (RCRA) and *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) are different (management of active waste facilities and cleanup of waste facilities). The shared goal is to develop plans and schedules to install the optimal number of new wells for groundwater monitoring. This recognizes that a variety of wells (shallow and deep) will be needed.
3. Problems need to be approached in a fresh way.
4. Establishing a sufficient monitoring network or networks will be a multi- year effort. The Tri-Parties need to agree on appropriate criteria for prioritization.
5. Prioritization must be implemented across the three statutes (RCRA, CERCLA, and the *Atomic Energy Act of 1954*).
6. The extensive groundwater contaminant plumes of tritium, nitrate and iodine-129 have resulted from past-practice discharges to the soil at cribs, ponds and ditches. These discharges were generally high-volume and of relatively low concentration. However, there is relatively little inventory that remains in the vadose zone that is long-lived and mobile and could contribute to additional groundwater contamination in the future. It is assumed that most of the liquids discharged to the soil have drained, and the soil at these sites may be approaching field capacity. Characterization will be needed prior to site closure to confirm this.
7. Further investigations and additional monitoring are required to deal with the carbon tetrachloride plume.
8. Current remedial actions need to focus on carbon tetrachloride, chromium, strontium-90 (100-N Area), technetium-99, and uranium. As other contaminant plumes are discovered they will be prioritized.
9. Carbon tetrachloride characterization is less mature than the other contaminants listed in item 8.
10. There is likely a large inventory of long-lived and mobile contaminants in the vadose zone from past leaks at single-shell tanks, overflow from tanks to cribs, and in specific retention trenches where tank waste was disposed to the soil. It is assumed that long-lived and mobile contaminants in the vadose zone have or will impact groundwater in the future. Characterization data and detection monitoring are both important for the single-shell tank sites.

11. The design for new groundwater monitoring wells needs to anticipate the dynamics of the aquifer. In some areas, existing monitoring wells are going dry and the direction of groundwater is changing. The significant inventory of mobile and long-lived contaminants, dropping water level, and dynamics in flow directions and rates justify upgrades to the monitoring system.
12. There are opportunities for cost efficiencies in the areas of investigation-derived waste management, purge water management, sampling schedules, number of contaminants, and statistical approaches.
13. The impact of discharges from septic systems on contaminant movement in the vadose zone and on groundwater flow needs to be better understood.

D.1 References

Atomic Energy Act of 1954. 1954. Public Law 83-703, as amended, 68 Stat. 919, 42 USC 2011 et seq.

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act. 1980. Public law 96-150, as amended, 94 Stat. 2767, 42 USC 9601 et seq.

RCRA – Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

Appendix E

Letter to the Hanford Advisory Board on Exposure Scenarios For The 200 Area

02-HAB-0006

Mr. Todd Martin, Chair
Hanford Advisory Board
1933 Jadwin Avenue, Suite 135
Richland, Washington 99352

Dear Mr. Martin:

CONSENSUS ADVICE #132: EXPOSURE SCENARIOS TASK FORCE ON THE 200 AREA

This is in response to your advice #132 dated June 7, 2002, regarding the Central Plateau risk framework and exposure scenario development.

The three agencies appreciate the effort the Board has undertaken to provide us with advice as we enter this critical phase of remediation and closure of Hanford's Central Plateau. Your advice, combined with the input we received from Tribal Nations and interested citizens, provided us with the guidance we needed to develop a credible exposure scenario for the Central Plateau.

We believe that the risk framework delineated in the attachment to this letter adheres closely to your advice. In the cases of minor departure, the agencies considered your advice and made the decisions to deviate based on technical and logistical factors. The inclusion of S-Ponds and B-Pond in the core zone was based on the following: the need to expand the core zone to include the footprint of the Waste Treatment Plant (Vitrification Plant), and the need to avoid splitting waste sites of anticipated similar closure strategies. Notwithstanding such a deviation, the agencies fully support the notion of evaluating the possibility of shrinking the core zone. We support your advice to maximize the potential for beneficial uses in the core zone. The potential for extended human activities in the core zone would provide an added advantage of maintaining the knowledge of the waste left in the core zone after the remedial actions are completed.

We intend to fully integrate the decisions for the remediation of the source units with those for the remediation of groundwater using the appropriate regulatory process. Establishing points of compliance and remedial objectives will be done in adherence regulations. Also, we have started an effort to evaluate groundwater technologies necessary to deploy to remediate groundwater in the core zone. This effort will be advanced through the regulatory documents and reviews of the corresponding groundwater operable units.

Mr. Todd Martin -2-
02-HAB-0006

One of the major missions the three agencies have embarked on is the coordination of the risk assessment efforts on the Central Plateau to maintain consistency in the standards used across the site, including data collection, accurate inventory, and land use assumptions.

The U.S. Department of Energy is developing a Long-Term Stewardship (LTS) Plan for the Hanford Site. The recommendation for the creation of a "coalition of groups, to include the Tribes, local government, and other affected entities" to administer the LTS responsibilities of the site should be discussed and evaluated within the context of developing the site LTS Plan. We welcome any proposals from the Board to start such a discussion and evaluation.

We reiterate our appreciation for the work you have done to support the risk framework. If you need further information or assistance, please contact the U.S. Department of Energy, Richland Operations Office, Public Involvement Manager, Yvonne Sherman on (509) 376-6216.

Keith A. Klein, Manager
U.S. Department of Energy
Richland Operations Office

David R. Einan
Acting Hanford Project Manager
U.S. Environmental Protection Agency

Michael A. Wilson, Program Manager
State of Washington Department of Ecology

IPI:YS

Attachment

Attachment

Decision Strategy (Risk & Regulatory Framework)

Risk Framework Description (Tri-Party Agreement):

1. The Core Zone (200 Areas including B Pond (main pond), and S Ponds) will have an Industrial Scenario for the foreseeable future.
2. The Core Zone will be remediated and closed allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of the wastes left in place for the future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users, and to intruders.
3. DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and remedial action objectives. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 years). It is assumed that the tritium and iodine-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the period of the next 150 to 300 years (less for the tritium plume). It is expected that other groundwater contaminates will remain below, or be restored to drinking water levels outside the Core Zone.
4. No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for in assessing the risk to human health and environment.
5. Waste Sites outside the Core Zone but within the Central Plateau (200 N, Gable Mountain Pound, B/C Crib Controlled Area) will be remediated and closed based on an evaluation of multiple land use scenarios to optimize land use, institutional control cost, and long term stewardship.
6. An Industrial land us scenario will set cleanup levels on the Central Plateau. Other scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making especially for:
   - The post-institutional controls period (>150 years).
   - Sites near the Core Zone perimeter to analyze opportunities to "shrink the site".
   - Early (precedent-setting) closure/remediation decisions.

7. This framework does not deal with the tank retrieval decision.